LWG
LOWER WILLAMETTE GROUP

Memorandum

To: Eric Blischke and Chip Humphrey, EPA Region 10

From: Lower Willamette Group

CC:

Date: October 30, 2008

Re: Review of benthic behavioral studies and acceptance/rejection criteria

On October 17, 2008, LWG and EPA ecotoxicologists and ecological risk assessment leads met to reconcile differences in their assessment of benthic tissue residue TRVs for the Portland Harbor baseline ecological risk assessment (BERA). One outcome of that meeting was an agreement by the LWG to reevaluate its decision to reject behavioral studies that EPA believes may establish direct links to reductions in growth, reproduction or survival of test organisms. The behavioral endpoints that EPA asked the LWG to reconsider are potentially related to feeding ability (reduced prey capture efficiency and filtration rate) and predator avoidance (decreased locomotion and burrowing). As a starting point, the LWG agree in principle that effects in feeding ability and predator avoidance may be directly linked to reductions in growth, reproduction and/or survival of test organisms. The question, then, is whether the particular studies in question made that link.

The LWG originally rejected ten lowest observed effect residues (LOERs) based on feeding ability and predator avoidance endpoints. Based on reevaluation of these studies after the October 17 meeting, the LWG will accept five of the 10 as summarized in the table and text below. We agree in principle that all four behavioral endpoints could be directly linked to survival, growth and/or reproduction, but only half of the specific benthic LOERs in question successfully met that standard.

Chemical	Reduction in capture of prey	Reduction in filtration	Decrease in locomotor activity	Delay in burrowing
Cadmium	1 (rejected)	2 (accepted)	1 (rejected)	2 (rejected)
Copper		1 (accepted)		
Zinc		1 (accepted)		
BEHP	1 (accepted)		1 (rejected)	

One cadmium study and one BEHP study yielded LOERs based on reduced ability to capture prey. We have accepted the BEHP study (Thuren and Woin 1991). We have rejected the cadmium study (Wallace et al. 2000) because the decrease in ability to capture prey was small (87-93% compared to control 97-100%) and based on observations taken over a very short period of time (2 hours). There is abundant information in the literature to suggest that aquatic organisms acclimatize to changes in metals exposure levels that initially cause low level effects such as were reported in this paper, so the

Wallace et al. (2000) LOER does not meet the standard of being directly linked to survival, growth or reproduction.

Three studies evaluated feeding as reduction in filtration rates. We have accepted all of those studies. In the paper by Duquesne et al. (2004) another LOER can be derived that is more directly linked to growth (based on condition index) and we have used that LOER instead of the filtration rate-based LOER. The other two papers were written by the same group (Kraak et al. 1994b; Kraak et al. 1994a). In the first paper they performed long term studies with zinc and lead looking at two endpoints filtration rate and mortality and they found that bivalves with reduction in filtration had an increase in mortality after 10 weeks exposure (the mortality LOER has been included in the SSD). Then they did some short term studies (48 hours) with zinc, cadmium, and copper and looked only at the filtration rates. Because they had previously proved a link between reduced filtration rate in their 48 hour test and mortality after 10 weeks exposure (using the same test species) we accepted these three LOERs.

For the other two behavior endpoints – delay in burrowing and reduction in locomotor activity – the specific studies in question did not link the observed behaviors to effects on survival, growth or reproduction. The delay in burrowing (Amiard and Amiard-Triquet 1986; Olla et al. 1988) was measured in seconds or minutes (maximum 25 min). As previously mentioned, the literature shows that aquatic organisms acclimatize to changes in metals exposure levels that initially cause low level effects such as were reported in these papers, so the burrowing behavior LOERs do not meet the standard of being directly linked to survival, growth or reproduction. The studies that reported reduced locomotor activity (Thuren and Woin 1991; Gerhardt 1990) measured behavioral effects over periods of up to 29 days, but the studies provided no evidence (either through experimental results or by reference to previous studies involving the same test organism and chemical) to link the observed behaviors to growth, reproduction or survival.

REFERENCES

Amiard JC, Amiard-Triquet C. 1986. Influence de differents facteurs ecologiques et de contaminaations metalliques experimentalies sur le comportement d'enfouissement de *Cardium edule* L. (Mollusques Lamellibranches). Wat Air Soil Pollut 27:117-130.

Duquesne SJ, Liess M, Bird DJ. 2004. Sub-lethal effects of metal exposure: physiological and behavioural responses of the estuarine bivalve *Macoma balthica*. Mar Environ Res 58:245-250.

Gerhardt A. 1990. Effects of subacute doses of cadmium on pH-stressed *Leptophlebia marginata* (L.) and *Baetis rhodani* Pictet (Insecta: Ephemoptera). Environ Pollut 67:29-42.

Kraak MHS, Wink YA, Stuijfzand SC, Buckert-deJong MC, de Groot CJ, Admiraal W. 1994a. Chronic ecotoxicity of Zn and Pb to the zebra mussel *Dreissena polymorpha*. Aquat Toxicol 30:77-89.

Kraak MHS, Toussaint M, Lavy D, Davids C. 1994b. Short-term effects of metals on the filtration rate of the zebra mussel *Dreissena polymorpha*. Environ Pollut 84:139-143.

Olla BL, Estelle VB, Swartz RC, Braun G, Studholme AL. 1988. Responses of polychaetes to cadmium-contaminated sediment: comparison of uptake and behavior. Environ Toxicol Chem 7:587-92.

Thuren A, Woin P. 1991. Effects of phthalate esters on the locomotor activity of the freshwater amphipod *Gammarus pulex*. Bull Environ Contam Toxicol 46:159-166.

Wallace WG, Brouwer TM, Brouwer M, Lopez G. 2000. Alterations in prey capture and induction of metallothioneins in grass shrimp fed cadmium-contained prey. Environ Toxicol Chem 19(4):962-971.